of electricity for the generation of heat has come the need for greater accuracy in calculating the rate of heat flow through insulation, the temperature distribution in bodies after any time interval, etc. In 1811 Fourier developed the mathematical theory of the conduction of heat, but until lately the practical applications have been few. The "Mathematical Theory of Heat Conduction," by L. R. Ingersoll and O. J. Zobel, although primarily a text-book, is a step towards making Fourier's methods available to the engineer.

After a historical sketch in the first chapter, the authors derive the Fourier conduction equation from the fundamental laws of the flow of heat. This equation is solved first, for bodies in which the temperature distribution has become steady. These bodies are the thin plate, the long thin rod, the infinitely long thin rectangular plate, etc. The general cases in which the temperature is not steady are then attacked. Equations are developed, giving the temperature as a function of the variables time and distance, the temperature distribution at zero time being known. These general solutions require Fourier's series and integrals, which are developed, and extended to the limits $+\infty$ and $-\infty$. Solutions are given for such specific shapes as the infinite solid, the semi-infinite solid, the slab, the thin rod, the sphere, etc. Also solutions are given for the cases where there is either an instantaneous or a permanent source of heat in the interior of the body. No attempt is made to prove that any of the solutions are unique, as this rightfully belongs to larger treatises.

Throughout the work the authors give many numerical applications, such as calculating the flow of heat through furnace walls; the rate of cooling of a setting concrete wall in cold weather; the heating effect of thermit welding; the rate of cooling of steel in tempering; the rate of cooling of the earth, taking into account the effect of radioactivity; the rate at which heat penetrates a fire-proof wall, etc.

In deriving the fundamental equations the authors assume, in common with previous writers, that thermal resistivity does not vary with temperature. The error due to this assumption is usually unimportant for metals, but the so-called insulating materials often show large temperature coefficients. It is necessary to consider this in many cases if we are to secure accurate results. In dealing with problems involving heat losses from a surface exposed to the air, the authors follow the custom of assuming the rate of energy loss to be proportional to the temperature of the surface. It is well know that this is not true, and there is sufficient data available in the literature to allow a much closer approximation than can be secured with the above assumptions.

One of the most important applications of the theory of heat conduction is to problems in which there are permanent sources of heat, as in dealing with electric furnaces. The authors solve a few problems of this kind, but they do not give them nearly enough attention.

Considerably more values of thermal conductivity constants have been published than are given in the appendix. The statement that "in the constants for poorer conductors the disagreement between different observers is frequently 50 per cent. or more" is correct. But there need be no such disagreement if the conditions of the measurements are given.

The book is quite the most satisfactory yet published, as a text for the study of heat conduction, and it should be widely used in engineering schools. As a reference book for the practising engineer it leaves much to be desired, although the material included in it is made more easily available than heretofore. It is a long step towards the development of an engineering knowledge of the transmission of heat.

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SPECIAL ARTICLES

THE NEGATIVE PHOTOTROPISM OF DIAPTOMUS THROUGH THE AGENCY OF CAFFEIN, STRYCHNIN AND ATROPIN

SINCE the discovery that fresh-water crustacea which are normally indifferent to light could be made positively phototropic by means

of acids, alcohols and esters,[1] there have been various attempts to bring about a negative reaction by chemical means. It is true that raising the temperature, or the addition of alkalis, tends to break up positive collections of these animals, but such treatment does not cause a negative gathering. Until recently ultra-violet light of wave-length shorter than 3,341 A. u. has been the only generally successful means of artificially causing a negative collection of fresh-water crustacea.[2] But it has lately been shown by Drzewina[3] that the larvæ of lobsters give such a negative response when treated with potassium cyanide.

In a former paper it was pointed out that the addition of strychnin to water containing *Daphnia* destroys the positively phototropic responses of these animals, and that such treatment when applied to *Diaptomus* causes them to form a strong negative collection. Atropin gives the same result, but to a less marked degree.[4]

In order still further to test the effect of alkaloids and other substances upon the light reactions of fresh-water crustacea, the following experiments were carried out at the New Monterey laboratory during December, 1912. The material used consisted of *Diaptomus bakeri*[5] taken from the Del Monte lake. The freshly collected animals were put into finger-bowls, each of which contained 25 c.c. of lake water. The preparations were then placed upon a table near the window, but never in direct sunlight. Normally, *Diaptomus* is indifferent to light, the individuals remaining pretty evenly distributed about the dish. But the addition of acids, alcohols or ether always causes the animals in the dish treated to form a dense collection on the window side. In order to insure equal concentration of a given substance throughout the preparation, the latter was always thoroughly stirred after the addition of the reagent.

If, now, to a normal preparation there be added 0.6 c.c. of a 1 per cent. solution of caffein, in two minutes the animals all collect in a dense cluster on the side of the dish away from the light, *i. e.,* they become negatively phototropic. This collection remains thirty to thirty-five minutes. It was thus possible to observe opposite effects in two dishes of the same material placed side by side, the one with all of the animals forming a dense cluster nearest the window (caused by adding the acid), the other with all the animals collected on the side of the dish farthest from the window (caused by adding the caffein). In either case after the characteristic gathering, if the dish be turned through an angle of 180° the crustacea in it swim back across the dish and re-form, the collection having the former position with reference to the light. The addition of 0.05 c.c. of a ½ per cent. solution of strychnin nitrate to a normal preparation causes all of the animals to become negatively phototropic, but does not result in their forming a dense collection as in the case of caffein. Strychnin, because of its toxicity, causes the *Diaptomus* treated with it to die within five minutes. It was also found that if 0.5 c.c. of a ¼ per cent. solution of atropin (alkaloidal) be added to a normal preparation of *Diaptomus,* we obtain much the same result as with strychnin, *i. e.,* a weak negative collection. Other alkaloids such as digitalin, pilocarpin, physostigmin, ricin and cocain, gave no significant results with this form.

If the *Diaptomus* were first made positively phototropic by the addition of alcohol or acids, it was found impossible to alter their response by the action of caffein, strychnin or atropin. On the other hand, animals which had formed a negative collection under the influence of caffein, if treated with carbonated water, at once changed their response and, swimming to the light side of the dish, formed a positive gathering. This confirms my former statement:

[1] Loeb, J., "Dynamics of Living Matter," p. 131.

[2] Loeb, G., *Pflüger's Archiv*, Bd. 115 s.; Moore, A. R., *Journ. Exp. Zool.*, Vol. 13, p. 573.

[3] Drzewina, Anna, *C. R. Soc. Biol.*, Vol. 71, p. 555.

[4] Moore, A. R., Univ. Calif. Publ. Physiology, Vol. 4, p. 185.

[5] I am indebted to Professor Kofoid for the identification of this form.

While negative phototropism in *Diaptomus* can be reversed by acids, positive phototropism brought about by chemical means can not be reversed by strychnin (atropin or caffein).[6]

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July 8, 1913

THE POWDERY SCAB OF POTATO (SPONGOSPORA SOLANI) IN MAINE

THE potato tuber scab caused by *Spongospora Solani* (Brunch) has been known in Europe since 1842. It was recently reported from Canada by Güssow,[1] but has hitherto not been found in the United States. That it would become established here has been feared by those acquainted with the serious injuries it causes in Great Britain, whence heavy importations of potatoes were made in 1911 and previous years, to supply American markets.

The writer discovered this disease on June 23 in potatoes just brought to Houlton from Presque Isle, Aroostook County, Maine. There is no probability as yet that a large amount of *Spongospora* exists there, but 84 diseased tubers were sorted out of four barrels, which represented a lot of 500 barrels.

The milder forms of powdery scab resemble the common Oospora scab. The pustules are at first closed, but later break out into large open sori. Twenty-six of the tubers collected showed this form.

The source of the disease is not known. The original infection may have been brought from Europe before the Plant Quarantine Act went into effect or seed potatoes bearing the disease may have come from the adjacent province of New Brunswick, in Canada, where powdery scab already occurs.

It is hoped that pathologists all over the country will now watch for this disease and that every effort be made to stamp it out.

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[6] Moore, A. R., loc. cit.

[1] *Phytopathology*, February, 1913, p. 18.

A NEW SECTION SOUTH FROM DES MOINES, IOWA

THE grading of a new railroad line from Des Moines to Allerton, passing from Polk County through Warren, Marion and Lucas into Wayne County, affords an excellent series of exposures such as have never before been available in this region. The relation which this series makes evident assists in the interpretation of observations already recorded, and the section itself serves as a standard with which to compare work yet to be accomplished in south central Iowa and adjacent Missouri. The general relation will be of interest to all who keep informed on the Pleistocene work of the country.

The Loess

The best exposure of loess that the writer has seen in this portion of the state is south of Des Moines, half a mile north of Coon Valley. Here twelve to fifteen feet of grayish yellow porous loess with faint horizontal lamination may be seen capping the bluff for a quarter of a mile. At the two ends of the cut the loess is exceedingly fossiliferous, and charged with concretions. In the hills east of Carlisle, even as far as Hartford, a distinct fossiliferous loess may be seen; but further south it does not form a conspicuous deposit. On the brow of hills away from the highest portion of the upland it is not present at all.

The "Gumbo"—The Loveland

Along the sides of all cuts through the upland may be seen a clay yellowish above, bluish below, of a thickness varying from a few feet up to perhaps twenty feet. It is nearly free from pebbles, but here and there a few scattered ones may be found that are half an inch in diameter, and very rarely one as large as an inch. Two were recently found as large as two inches in diameter. There are found scattered through the clay grains chiefly of granite about an eighth of an inch in diameter. The clay is generally free from distinct stratification, often silty in appearance, and slumps badly throughout the entire length of the railroad. In the upland where thickest it is found on the bowlder and pebble-bearing portion of the Kansan drift with no